

Accuracy Characteristics for Final Delivery Scenario Hours 1500-2000 Interfacility

1 Introduction

This document contains scenario characteristics for hours 1500 to 1200 GMT recorded on May 26, 1999 at Memphis ARTCC and cover either the ZME or ZID airspace. Characteristics to be provided are general statistics determined from the scenario on airspace characteristics, aircraft to aircraft and aircraft to airspace encounters, general air traffic, aircraft, flight plan adherence, interfacility traffic flow and deviations in weather forecasts. Definitions of the provided scenario characteristics are provided in Reference[1].

2 Reference

[1] Paglione, M., Oaks, R., Ryan, Dr. H., Summerill, J.S., (Final, January 2000), *Description of Accuracy Scenarios for the Acceptance Testing of the User Request Evaluation Tool (URET) / Core Capability Limited Deployment (CCLD)*, FAA William J. Hughes Technical Center / ACT-250, Atlantic City, New Jersey.

NOTE – Section numbers in this document do not map to those of the reference document.

3 Center Airspace

This section corresponds to Section 3.1 of Reference[1]. The below data corresponds to the ZME Center using the May 20, 1999 ACES chart cycle. Information gathered from running URET PRE, accessing the ZME Center Internet site and local knowledge.

Metric	Definitions	Count
Center Area	Approximate Square Miles	120000
Airports	From URET DU Adaptation List	778
Sectors	From URET DU Adaptation List	110
SAA	Special Activities Airspace	57
APDIA	Automated Problem Detection Inhibited Area	20
SID	Standard Instrument Departure	11
STAR	Standard Arrival Route	10
PAR	Preferential Arrival Route	594
PDR	Preferential Departure Route	346
PDAR	Preferential Departure Arrival Route	124

4 Aircraft Encounter Distributions

The statistics collected in this section characterize aircraft to aircraft encounters. The encounter counts are partitioned by selected minimum horizontal separation intervals, a count of encounters partitioned by standard flight levels, and by vertical phase of flight and aircraft encounter angle. This section corresponds to Section 3.2.1 in Reference[1].

4.1 Count Partitioned by Minimum Horizontal Separation

This section corresponds to Section 3.2.1.1 in Reference[1].

Table 1: Count of Current Plan Aircraft Encounters

Min. Horz. Separation (nm)	Without Adherence	13 Minutes Adherence
$0 \leq d < 5$	142	97
$5 \leq d < 10$	175	115
$10 \leq d < 15$	246	141
$15 \leq d < 23$	474	284
$23 \leq d < 30$	431	246
Total	1468	883

Table 2: Count of Trial Plan Aircraft Encounters

Min. Horz. Separation (nm)	Without Adherence	20 minutes Adherence
$0 \leq d < 5$	142	93
$5 \leq d < 10$	175	114
$10 \leq d < 15$	246	136
$15 \leq d < 24$	548	317
$24 \leq d < 30$	357	194
Total	1468	854

4.2 Count Partitioned by Altitude for Standard Separation Intervals

This section corresponds to Section 3.2.1.2 of Reference[1].

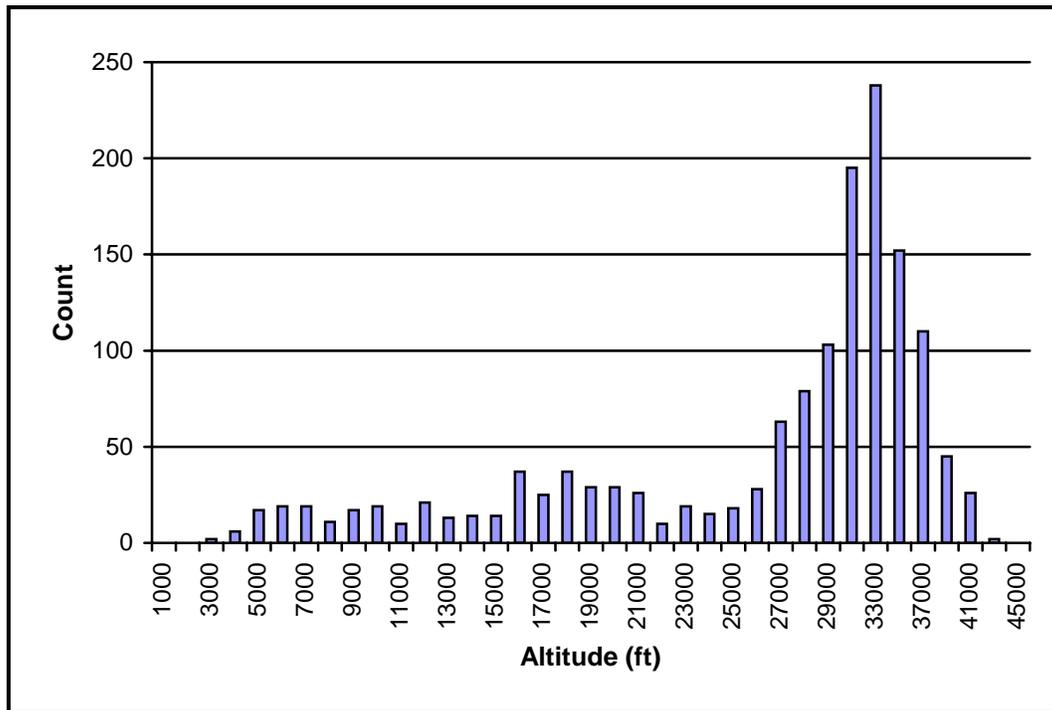


Figure 1: Aircraft to Aircraft Encounters by Altitude

4.3 Count Partitioned by Vertical Phase of Flight and Encounter Angle

This section corresponds to Section 3.2.1.3 of Reference[1].

Table 3: Count of Aircraft Encounters Partitioned by Phase of Flight and Encounter Angle

Vertical Phase	Encounter Angles (deg)				Total
	[0, 45)	[45, 90)	[90, 135)	[135, 180]	
Cruise-Cruise	102	112	50	42	306
Descend-Descend	27	21	13	13	74
Climb-Climb	17	14	3	9	43
Cruise-Climb	168	86	90	106	450
Cruise-Descend	152	91	88	134	465
Climb-Descend	33	16	18	31	98
Unknown	21	8	1	2	32
Total	520	348	263	337	1468

5 Airspace Encounter Distributions

This section provides statistics on aircraft to airspace encounters. Three areas considered are counts partitioned by selected minimum horizontal separation intervals, an encounter count partitioned by standard flight levels, and a count partitioned by vertical phase of flight and airspace encounter angle. Additionally, vertical phase of flight count is separated into top, bottom and side airspace encounters and for encounters with unknown encounter angles. The section corresponds to Section 3.2.2 of Reference[1].

5.1 Count Partitioned by Minimum Horizontal Separation

The section corresponds to Section 3.2.2.1 of Reference[1].

Table 4: Count of Current Plan Airspace Encounters by Horizontal Separation

Min. Horz. Separation (nm)	Without Adherence	13 minutes Adherence
Conflicts ¹	2242	1913
$d = 0^2$	37	29
$0 < d < 7$	844	679
$7 \leq d < 9$	228	170
$9 \leq d < 11$	213	159
$11 \leq d < 16$	539	424
$16 \leq d < 30$	1804	1418
Total	5907	4792

Table 5: Count of Trial Plan Airspace Encounters by Horizontal Separation

Min. Horz. Separation (nm)	Without Adherence	20 minutes Adherence
Conflicts ³	2242	1870
$d = 0^4$	37	27
$0 < d < 8$	963	761
$8 \leq d < 11$	322	238
$11 \leq d < 13$	212	162
$13 \leq d < 19$	708	562
$19 \leq d < 30$	1423	1064
Total	5907	4684

¹ This count includes encounters that are conflicts. By definition the minimum horizontal separation is zero and the track point actually penetrates the airspace.

² This count includes encounters without valid airspace penetrations, which occurs under two cases: a short duration penetration or an encounter on the actual buffered boundary of the airspace which does not penetrate.

³ This count includes encounters that are conflicts. By definition the minimum horizontal separation is zero and the track point actually penetrates the airspace.

⁴ This count includes encounters without valid airspace penetrations, which occurs under two cases: a short duration penetration or an encounter on the actual buffered boundary of the airspace which does not penetrate.

5.2 Count Partitioned by Altitude

This section corresponds to Section 3.2.2.2 of Reference[1].

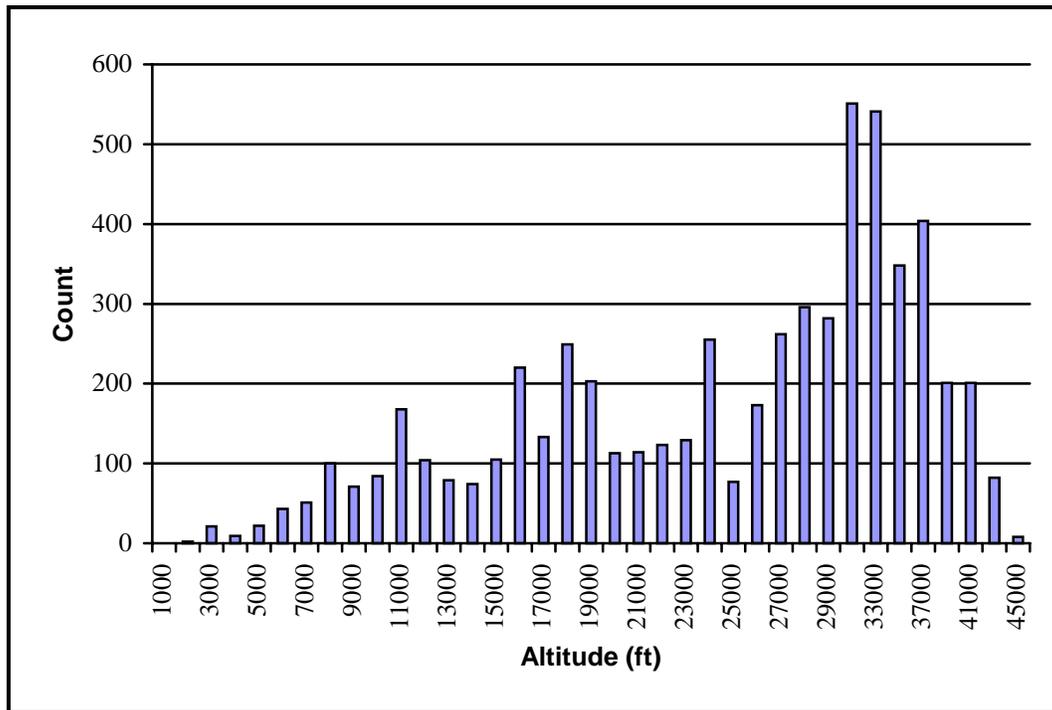


Figure 2: Airspace to Airspace Encounters by Altitude

5.3 Count by Vertical Phase of Flight and Encounter Angle

This section corresponds to Section 3.2.2.3 in Reference[1].

Table 6: Count of Airspace Encounters by Angle and Vertical Phase of Flight for Side Conflicts

Vertical Phase	Encounter Angles (deg)			Total
	[0, 30)	[30, 60)	[60, 90)	
Climb	12	66	131	209
Cruise	192	536	761	1489
Descend	18	59	62	139
Total	222	661	954	1837

Table 7: Count of Airspace Encounters by Angle and Vertical Phase of Flight for Top and Bottom Conflicts

Vertical Phase	Encounter Angles (deg)			Total
	[0, 30)	[30, 60)	[60, 90)	
Climb	155	0	0	155
Cruise	3	0	0	3
Descend	22	0	0	22
Total	180	0	0	180

Table 8: Count of Airspace Encounters by Vertical Phase of Flight with Unknown Angles

Vertical Phase	Count
Climb	47
Cruise	146
Descend	32
Total	225

6 Air Traffic Distributions

This section provides metrics that characterize the air traffic. The metrics are flight density partitioned by standard flight levels, flight type and sector penetration, statistics on the number of active flights, ground speed statistics, counts of interim altitude and amendment messages, and air traffic maneuvers by altitude and phase of flight. This section corresponds to Section 3.3 of Reference[1].

6.1 Air Traffic Density

This section corresponds to section 3.3.1 of Reference[1]. Detailed statistics on aircraft encounters are provided in Appendix A.

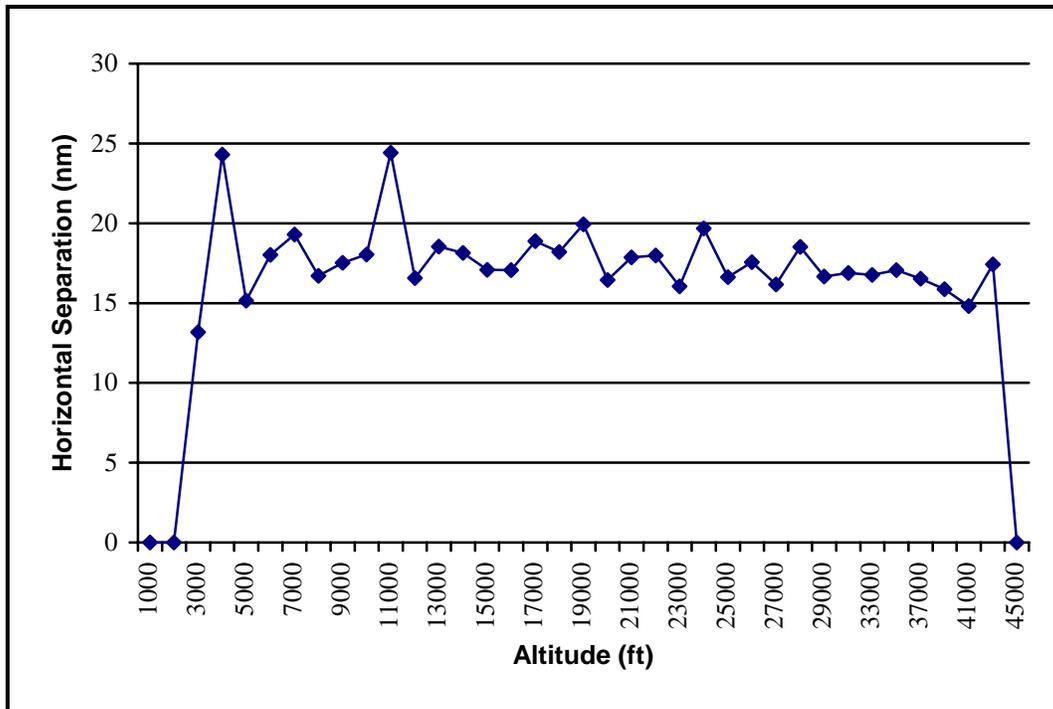


Figure 3: Average Horizontal Separation by Altitude for All Hours

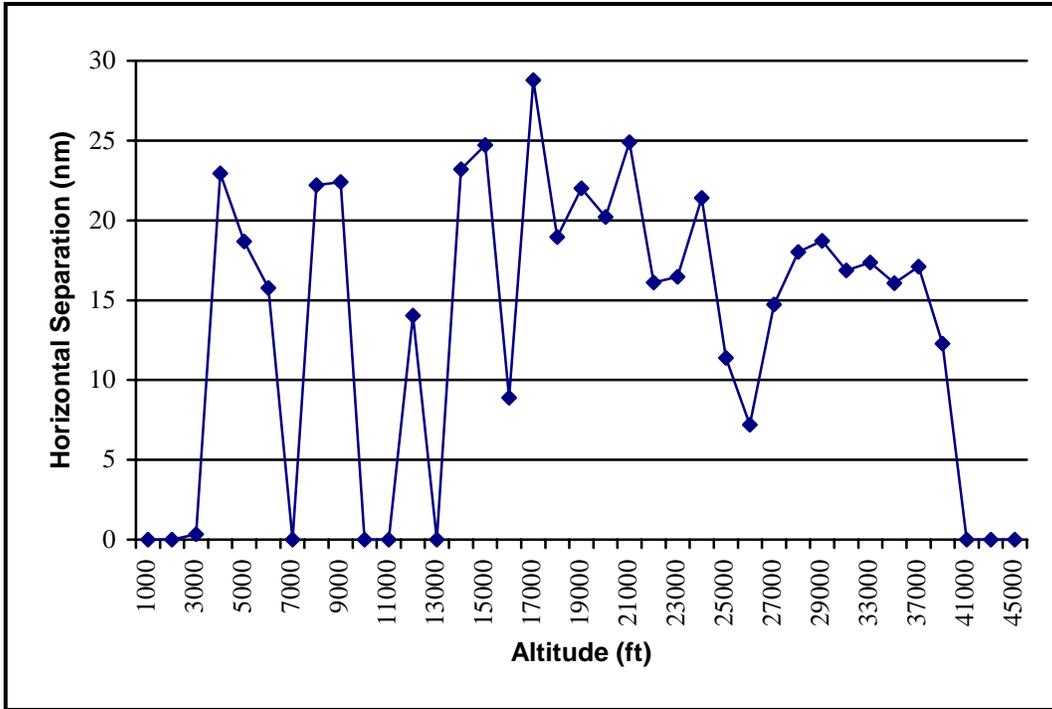


Figure 4: Average Horizontal Separation by Altitude for Hour 1

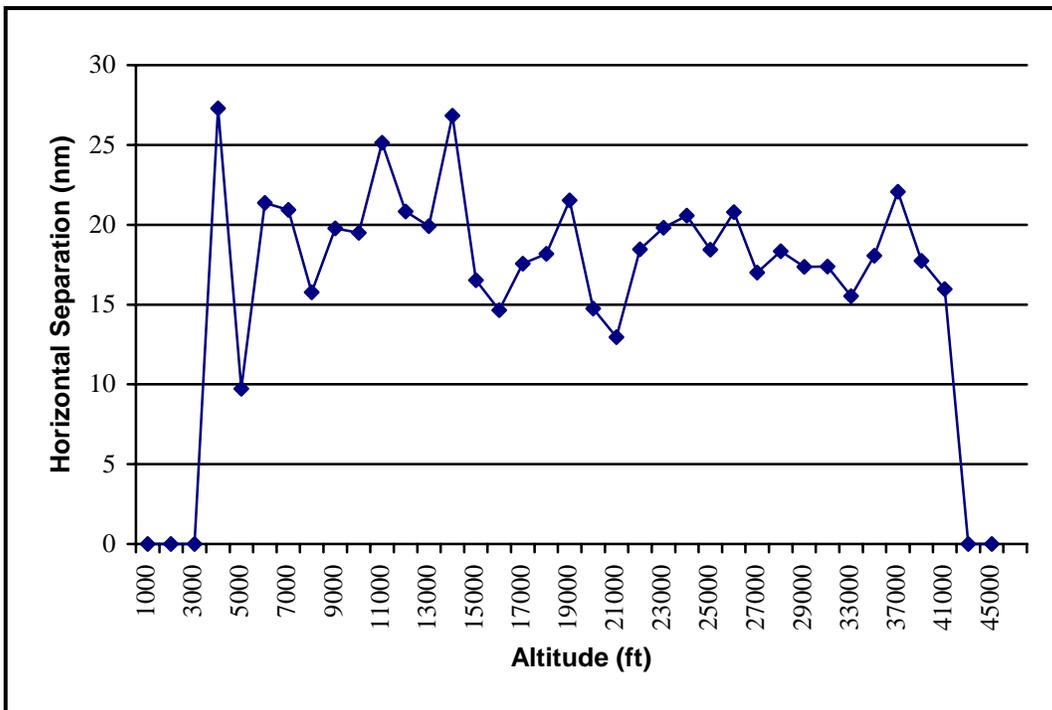


Figure 5: Average Horizontal Separation by Altitude for Hour 2

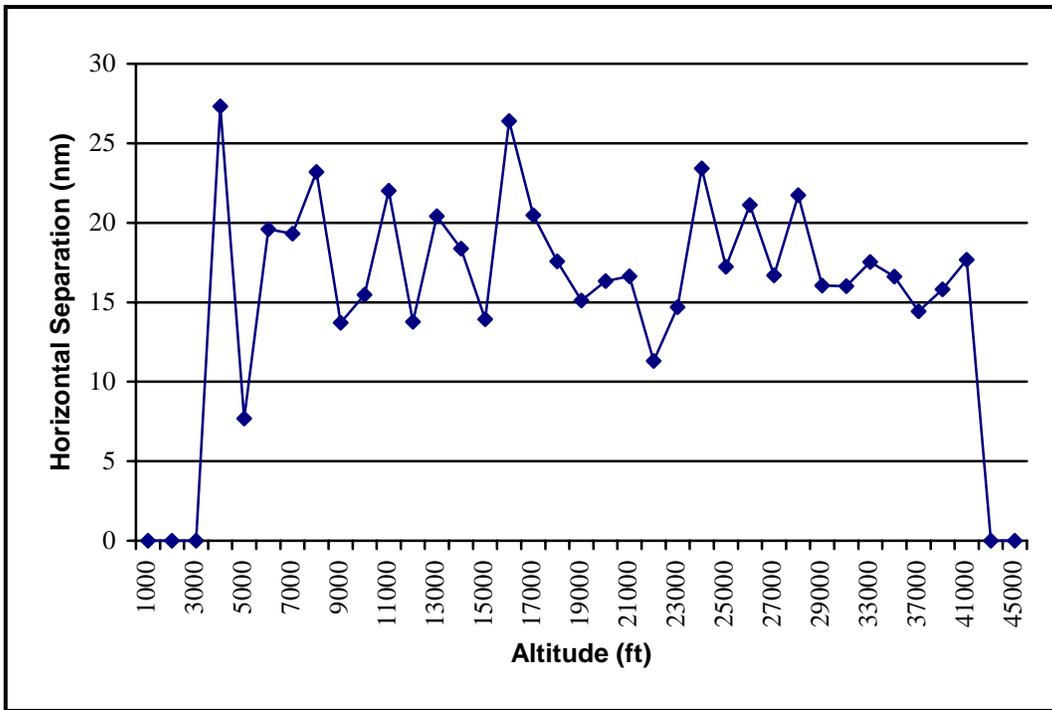


Figure 6: Average Horizontal Separation by Altitude for Hour 3

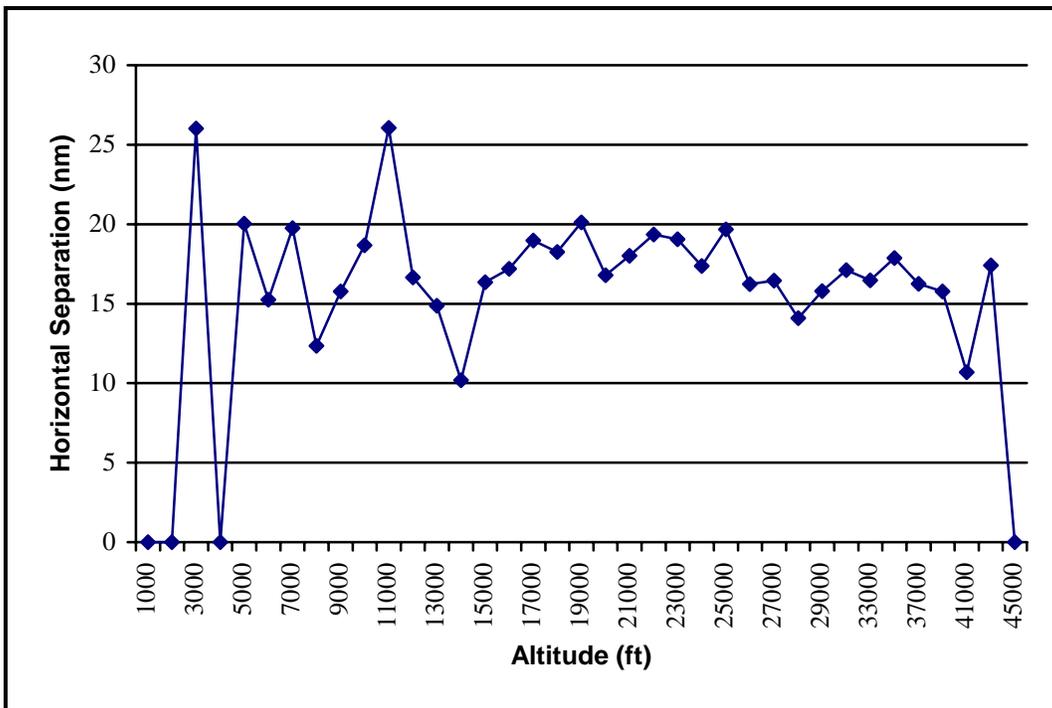


Figure 7: Average Horizontal Separation by Altitude for Hour 4

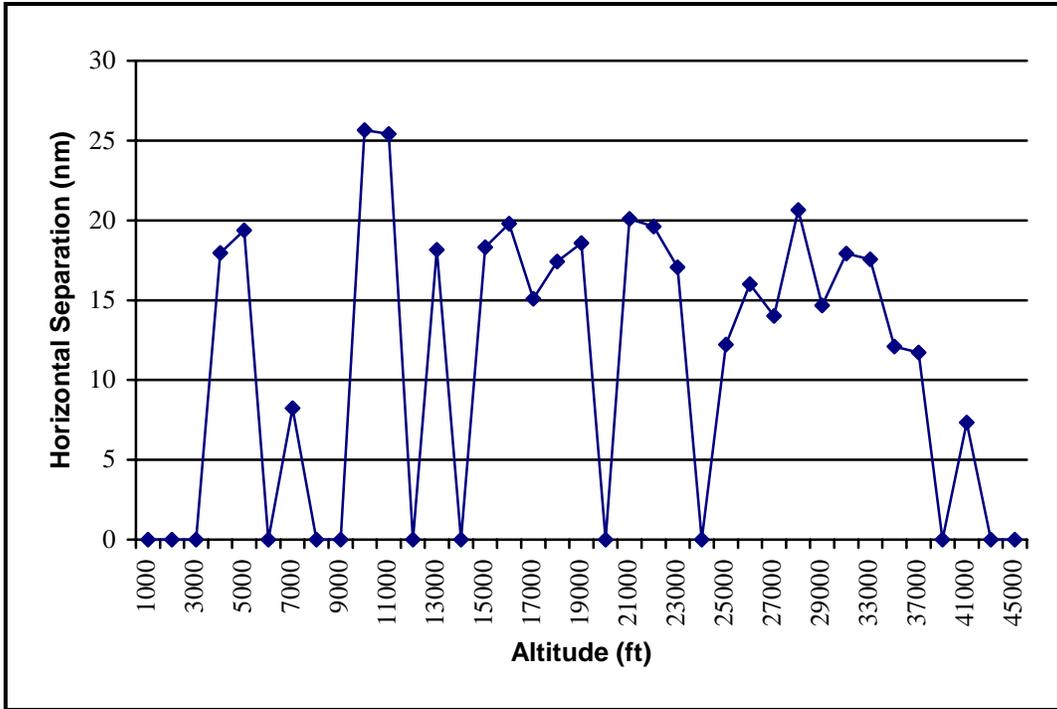


Figure 8: Average Horizontal Separation by Altitude for Hour 5

6.2 Active Flights

This section corresponds to section 3.3.2 of Reference[1].

Table 9: Statistics on Active Flights per Minute Increment

Count Average	Standard Deviation	Maximum Count	Minimum Count
189.870	82.241	290	0

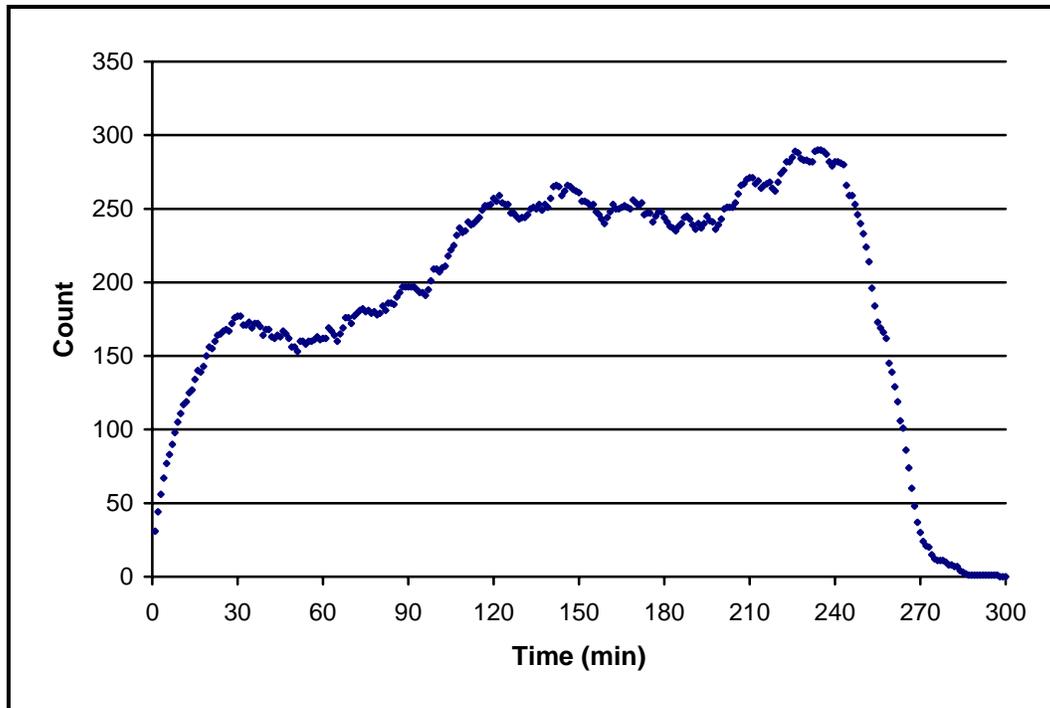


Figure 9: Count of Active Flights per Minute Increment

6.3 Flight Type and Sector Penetration

This section corresponds to Section 3.3.3 of Reference[1].

Table 10: Statistics on Sector Time, Center Time and Sector Penetration by Flight Type

Metric	Arrivals	Departures	Internals	Overflights	All Flights
Average Number of Sectors Penetrated	2.056	2.145	1.881	2.466	2.270
Average Time in Center (sec)	1458.987	1184.188	1362.752	1818.053	1571.191
Average Time in Sector (sec)	687.440	532.537	682.732	727.461	676.010
Percentage by Flight Type	19.700	22.600	7.000	50.600	100.000

6.4 Ground Speed

This section corresponds to Section 3.3.4 of Reference[1]. Detailed statistics on aircraft ground speed are provided in Appendix B.

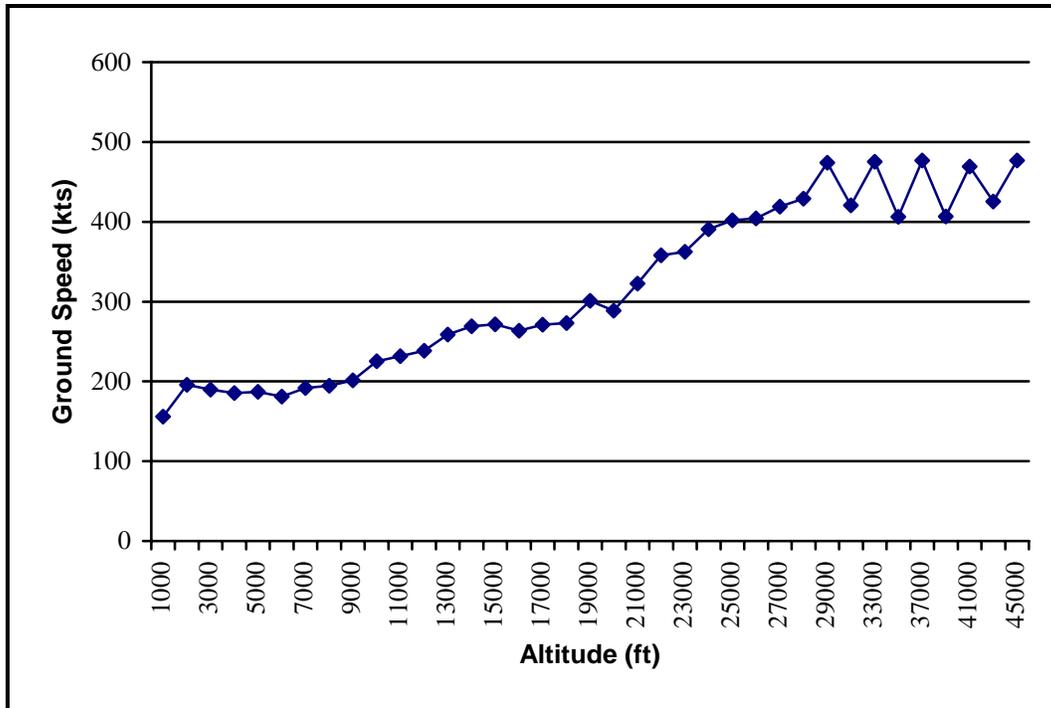


Figure 10: Average Ground Speed by Altitude for All Hours

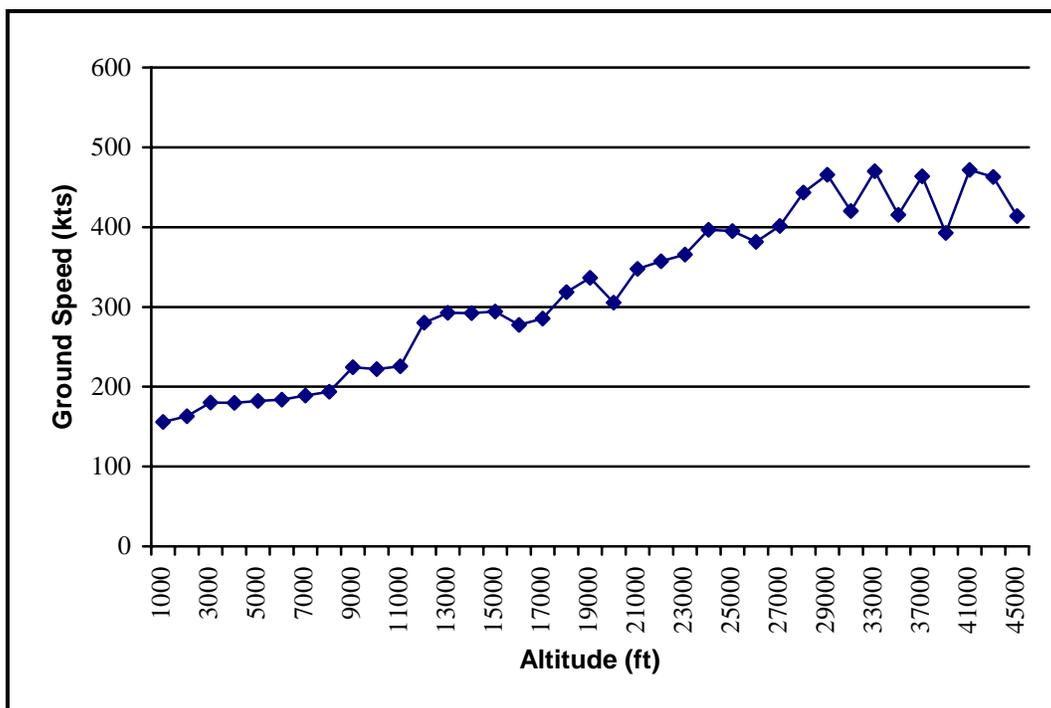


Figure 11: Average Ground Speed by Altitude for Hour 1

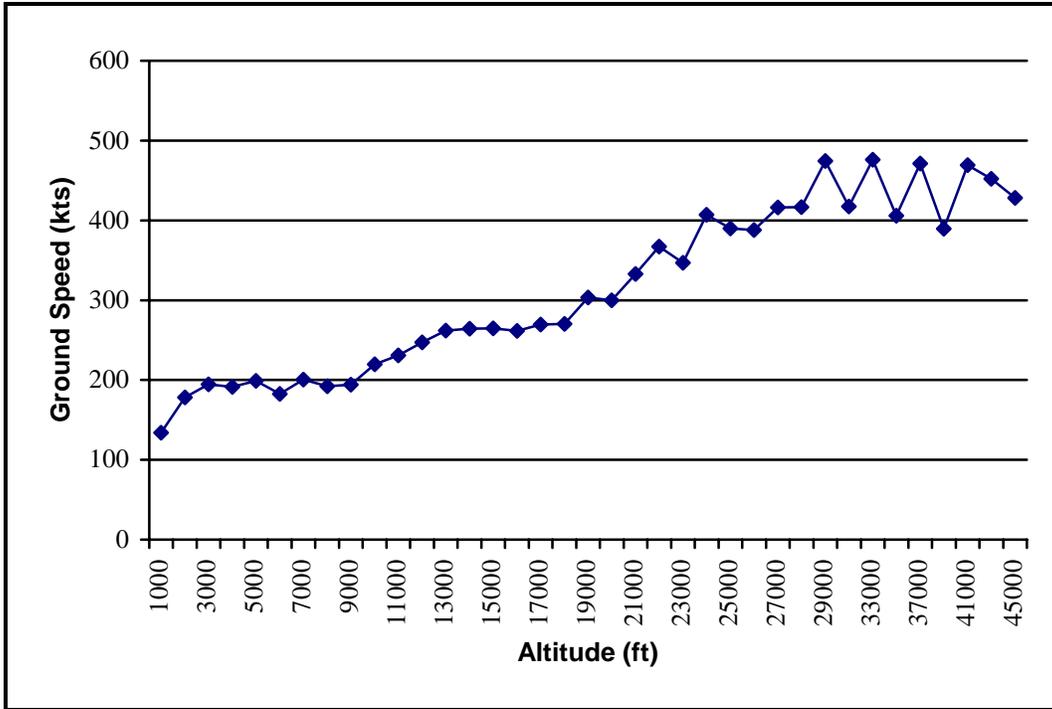


Figure 12: Average Ground Speed by Altitude for Hour 2

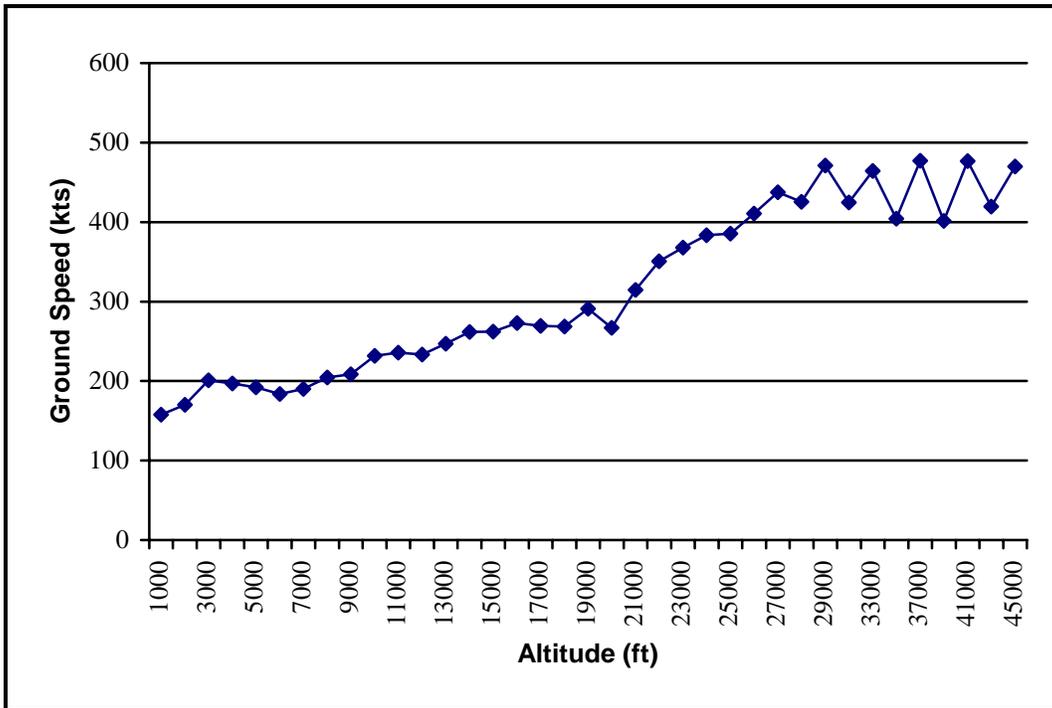


Figure 13: Average Ground Speed by Altitude for Hour 3

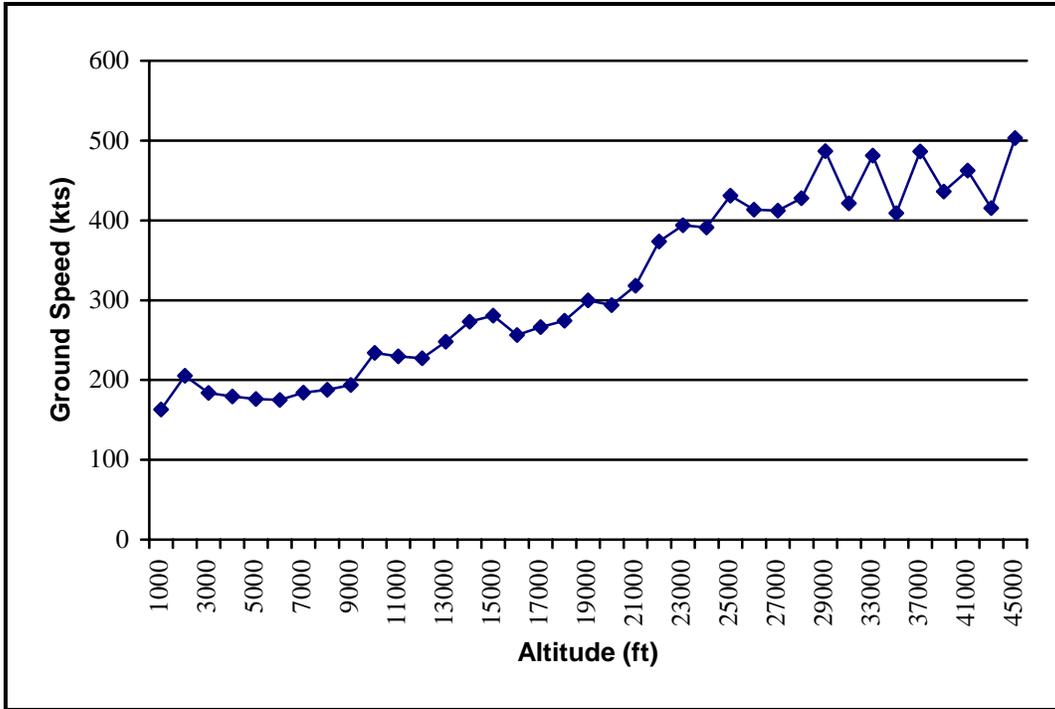


Figure 14: Average Ground Speed by Altitude for Hour 4

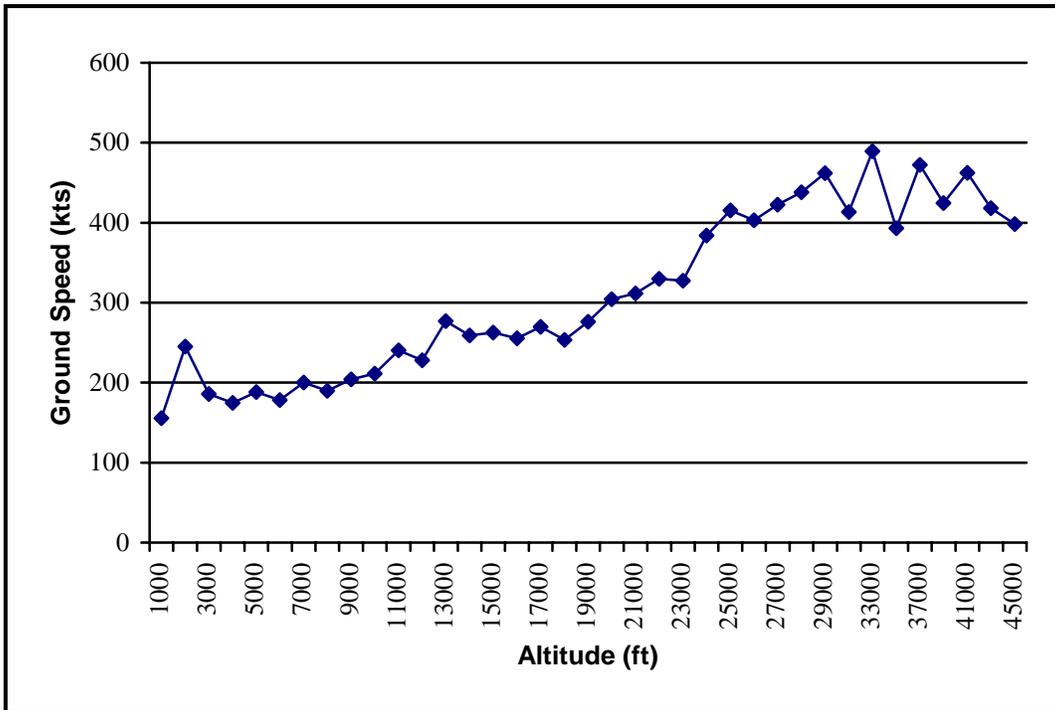


Figure 15: Average Ground Speed by Altitude for Hour 5

6.5 Center to APD Ratio

This section corresponds to Section 3.3.5 of Reference[1].

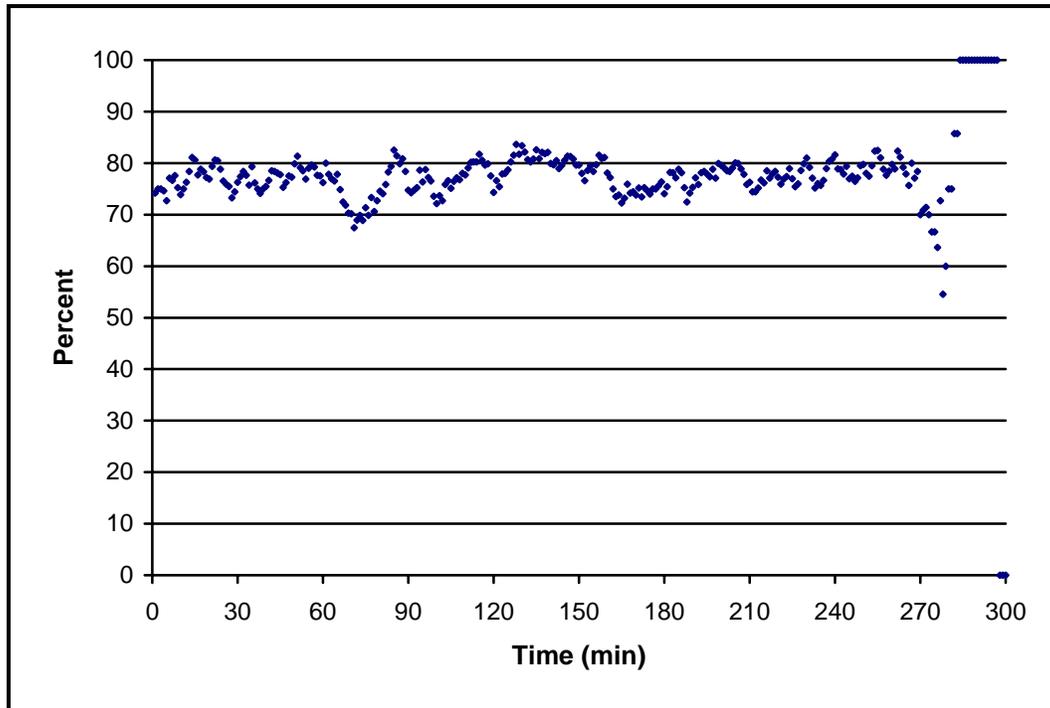


Figure 16: Percentage of Track Points in Center to APD Zone per Minute Increment

6.6 Interim Altitude Messages

This section corresponds to Section 3.3.6 of Reference[1].

Table 11: Statistics on Interim Altitude Messages⁵

Flight Count	Average	Standard Deviation	Maximum Count	Minimum Count
1094	2.868	1.151	8	1

6.7 Amendment Messages

This section corresponds to Section 3.3.7 of Reference[1].

Table 12: Statistics on Amendment Messages per Flight⁶

Flight Count	Average	Standard Deviation	Maximum Count	Minimum Count
762	1.966	1.264	10	1

⁵ Statistics on flights with interim altitude messages only

⁶ Statistics on flights with flight plan amendments only

6.8 Air Traffic Maneuvers

This section corresponds to Section 3.3.8 of Reference[1]. Detailed statistics on air traffic maneuvers are provided in Appendix C.

Table 13: Total Track Report Maneuver Count by Vertical and Horizontal Phase of Flight

Vertical Phase	Horizontal Phase of Flight		Total
	STR	TURN	
ASC	7987	1825	9812
DES	8594	1844	10438
LEV	3418	2028	5446
Total	19999	5697	25696

Table 14: Percent breakdown of Flight Tracks by Vertical and Horizontal Phase

Vertical Phase	Horizontal Phase of Flight		Margin (%)
	STR (%)	TURN (%)	
ASC	31.083	7.102	38.185
DES	33.445	7.176	40.621
LEV	13.302	7.892	21.194
Margin (%)	77.829	22.171	100.000

7 Aircraft Distributions

This sections provides the metrics used to characterize the aircraft provided in the scenario. The selected metrics are aircraft type, model, navigational equipment, and the air carriers operating in the airspace. The section corresponds to Section 3.4 of Reference[1].

7.1 Aircraft Type

This section corresponds to Section 3.4.1 of Reference[1].

Table 15: Count by Aircraft Type

Aircraft Type	Count	Percentage of Total
J	1053	67.241
P	209	13.346
T	301	19.221
Unknown	3	0.192
Total	1566	100.000

7.2 Aircraft Models

This section corresponds to Section 3.4.2 of Reference[1]. A full listing and count of aircraft models is provided in Appendix D.

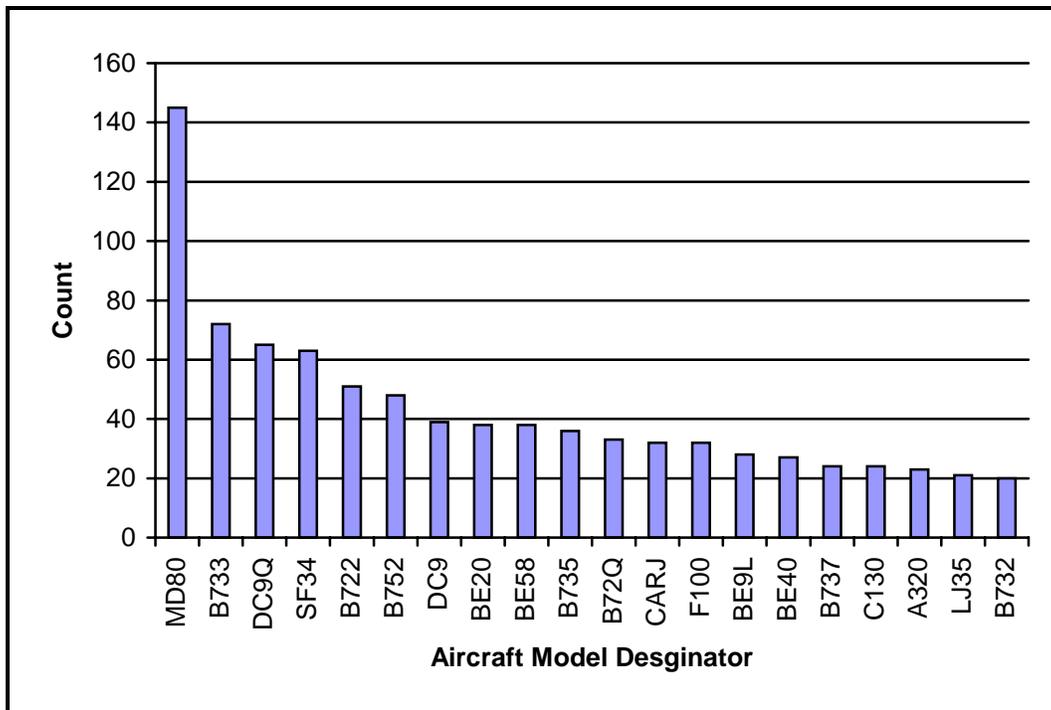


Figure 17: Count of Top Twenty Aircraft Models

7.3 Navigational Equipage

This section corresponds to Section 3.4.3 of Reference[1].

Table 16: Count by Aircraft Navigational Equipage Type

Nav. Equip. Designator	Count	Percentage of total
A	436	27.842
I	412	26.309
G	300	19.157
E	167	10.664
F	150	9.579
R	53	3.384
U	17	1.086
P	15	0.958
W	15	0.958
Unknown	1	0.064
Total	1566	100.000

7.4 Carrier Distribution

This section corresponds to Section 3.4.4 of Reference[1].

Table 17: Count by Carrier Type

Category	Count	Percentage of Total
Commercial	928	59.259
General Aviation	546	34.866
Other ⁷	92	5.875
Total	1566	100.000

⁷ Includes military and aircraft with unrecognized designators

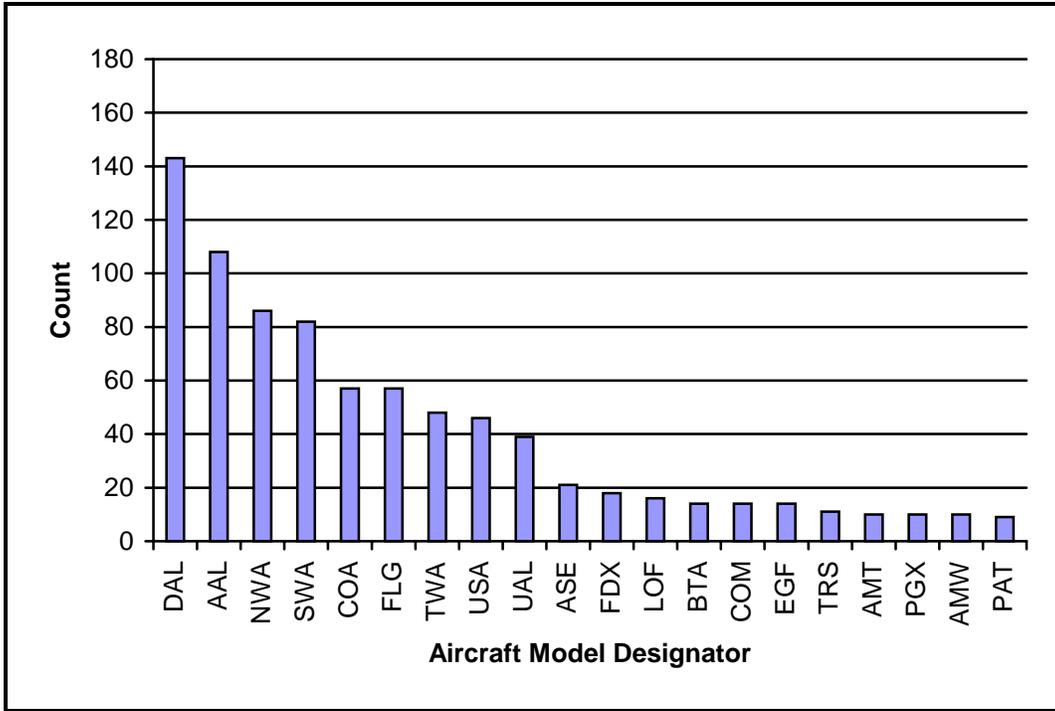


Figure 18: Count by Top Twenty Air Carriers

8 Flight Plan Adherence

This section provides statistics on lateral and vertical flight plan adherence and corresponds to Section 3.5 of Reference[1].

8.1 Lateral Flight Plan Adherence

This section corresponds to Section 3.5.1 of Reference[1].

Table 18: Statistics on Lateral Flight Plan Adherence by Altitude⁸

Upper Altitude (ft)	Flight Count	Max. Dist. Out (nm)	Min. Dist. Out (nm)	Average Dist. Out (nm)	Standard Dev.(nm)
10000	48	41	11	17.469	5.772
18000	46	51	13	22.742	8.856
33000	92	116	13	28.271	15.826
45000	52	65	14	26.685	8.079
Total	238				

8.2 Vertical Flight Plan Adherence

This section corresponds to Section 3.5.2 of Reference[1].

Table 19: Statistics on Vertical Flight Plan Adherence by Altitude⁹

Upper Altitude (ft)	Flight Count	Max. Dist. Out (ft)	Min. Dist. Out (ft)	Average Dist. Out (ft)	Standard Dev.(ft)
29000	675	43000	308	4016.757	3633.445
45000	246	21883	508	4608.538	3472.685
Total	921				

⁸ Statistics determined on tracks out of lateral adherence only.

⁹ Statistics were determined on tracks out of vertical adherence only.

9 Interfacility Traffic Flow

This section corresponds to Section 3.6 of Reference[1]. Table 20 duplicates Table 3.6-1 in reference and provides definitions for cells in Tables 21 and 22.

Table 20: Matrix of Traffic Sources in Scenario

Input - Flights into ZME	Output - Flights from ZME
Starts in ZID	Ends in ZID
Starts in ZME	Ends in ZME
Starts in Other Center	Ends in Other Center

Table 21: Statistics on Flights into ZME Airspace per minute

Input Flights	Average	Standard Deviation	Maximum Count	Minimum Count
From ZID	27.787	13.928	52	0
From ZME	57.763	23.998	97	0
From Other	104.320	54.126	168	0

Table 22: Statistics on Flights from ZME Airspace per minute

Output Flights	Average	Standard Deviation	Maximum Count	Minimum Count
To ZID	24.900	11.539	45	0
To ZME	65.120	37.843	162	0
To Other	99.850	46.930	158	0

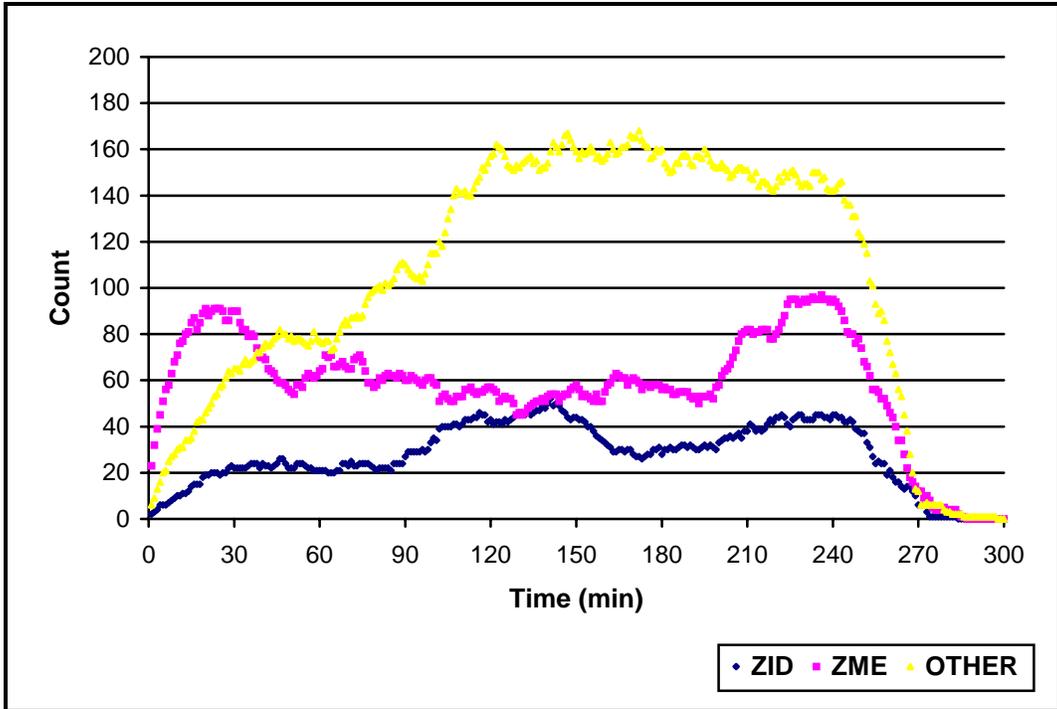


Figure 19: Flights into ZME from Legend Centers

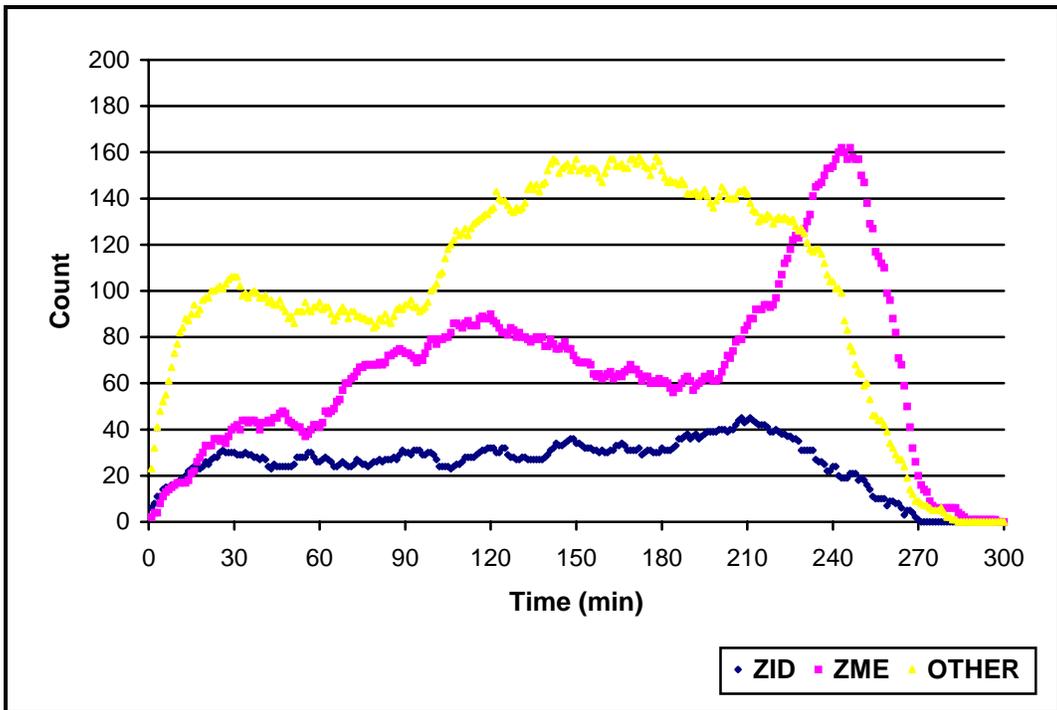


Figure 20: Flights from ZME to Legend Centers

10 Weather Variations

This section corresponds to Section 3.7 of Reference[1]. See the following document,

Kelly, Betty A., *User Request Evaluation Tool Core Capability Limited Deployment Accuracy Scenario Weather Forecast Deviation Study*, FAA William J. Hughes Technical Center / ACT-250, Atlantic City, New Jersey.

Appendix A: Supplement to Section 6.1 - Aircraft Traffic Density

Table 23: Statistics on Aircraft Encounters by Altitude Interval for All Hours

Upper Altitude (ft)	Aircraft Count	Avg. Horz. Sep.(nm)	Standard Dev.(nm)
1000	0	0.000	0.000
2000	0	0.000	0.000
3000	2	13.179	18.147
4000	6	24.302	3.983
5000	17	15.148	8.502
6000	19	18.028	6.497
7000	19	19.295	6.689
8000	11	16.711	7.692
9000	17	17.521	9.421
10000	19	18.034	8.539
11000	10	24.409	4.192
12000	21	16.559	8.680
13000	13	18.534	6.825
14000	14	18.149	6.860
15000	14	17.085	8.633
16000	37	17.063	7.612
17000	25	18.879	7.014
18000	37	18.195	6.126
19000	29	19.938	6.076
20000	29	16.436	7.070
21000	26	17.863	6.706
22000	10	17.979	5.266
23000	19	16.046	7.012
24000	15	19.679	7.169
25000	18	16.626	8.287
26000	28	17.555	7.824
27000	63	16.175	8.717
28000	79	18.522	7.876
29000	103	16.656	7.319
31000	195	16.874	7.877
33000	238	16.755	8.317
35000	152	17.064	7.745
37000	110	16.523	9.061
39000	45	15.875	7.960
41000	26	14.813	8.625
43000	2	17.416	14.389
45000	0	0.000	0.000
Total	1468		

Table 24: Statistics on Aircraft Encounters by Altitude for Hour 1

Upper Altitude (ft)	Aircraft Count	Avg. Horz. Sep.(nm)	Standard Dev.(nm)
1000	0	0.000	0.000
2000	0	0.000	0.000
3000	1	0.347	0.000
4000	2	22.946	2.473
5000	3	18.671	9.230
6000	1	15.766	0.000
7000	0	0.000	0.000
8000	1	22.201	0.000
9000	3	22.401	9.696
10000	0	0.000	0.000
11000	0	0.000	0.000
12000	1	14.031	0.000
13000	0	0.000	0.000
14000	1	23.205	0.000
15000	1	24.726	0.000
16000	1	8.889	0.000
17000	2	28.784	1.334
18000	7	18.955	4.582
19000	5	22.016	4.417
20000	2	20.213	10.804
21000	1	24.889	0.000
22000	1	16.103	0.000
23000	4	16.462	7.675
24000	1	21.415	0.000
25000	2	11.383	1.872
26000	1	7.196	0.000
27000	8	14.730	10.038
28000	14	18.026	6.993
29000	20	18.715	6.367
31000	45	16.866	7.868
33000	35	17.365	8.743
35000	9	16.073	9.242
37000	10	17.096	10.619
39000	4	12.280	7.693
41000	0	0.000	0.000
43000	0	0.000	0.000
45000	0	0.000	0.000
Total	186		

Table 25: Statistics on Aircraft Encounters by Altitude for Hour 2

Upper Altitude (ft)	Aircraft Count	Avg. Horz. Sep.(nm)	Standard Dev.(nm)
1000	0	0.000	0.000
2000	0	0.000	0.000
3000	0	0.000	0.000
4000	1	27.299	0.000
5000	4	9.730	7.513
6000	5	21.375	8.707
7000	5	20.935	3.251
8000	8	15.758	8.395
9000	4	19.783	7.432
10000	4	19.494	9.688
11000	4	25.128	3.659
12000	5	20.837	4.669
13000	2	19.909	3.224
14000	1	26.824	0.000
15000	5	16.520	7.027
16000	11	14.644	8.137
17000	6	17.553	6.561
18000	8	18.176	7.181
19000	7	21.537	4.816
20000	7	14.752	7.667
21000	2	12.958	3.318
22000	3	18.452	7.822
23000	1	19.823	0.000
24000	2	20.574	6.057
25000	3	18.447	10.027
26000	4	20.785	6.982
27000	5	17.011	7.916
28000	6	18.343	10.450
29000	17	17.371	8.182
31000	50	17.381	7.115
33000	51	15.522	8.524
35000	34	18.058	7.446
37000	19	22.057	7.476
39000	9	17.731	7.504
41000	3	15.969	6.745
43000	0	0.000	0.000
45000	0	0.000	0.000
Total	296		

Table 26: Statistics on Aircraft Encounters by Altitude for Hour 3

Upper Altitude (ft)	Aircraft Count	Avg. Horz. Sep.(nm)	Standard Dev.(nm)
1000	0	0.000	0.000
2000	0	0.000	0.000
3000	0	0.000	0.000
4000	2	27.325	1.478
5000	3	7.692	7.691
6000	5	19.590	5.532
7000	7	19.306	6.627
8000	1	23.193	0.000
9000	3	13.711	12.653
10000	7	15.470	9.975
11000	3	22.024	6.796
12000	7	13.770	10.552
13000	5	20.411	4.962
14000	10	18.368	5.126
15000	2	13.920	15.156
16000	2	26.390	1.144
17000	4	20.468	8.375
18000	6	17.573	5.140
19000	4	15.111	9.451
20000	6	16.333	8.368
21000	5	16.628	6.989
22000	1	11.298	0.000
23000	10	14.697	7.550
24000	4	23.419	7.459
25000	5	17.225	10.858
26000	6	21.116	6.336
27000	24	16.686	7.905
28000	25	21.734	7.590
29000	32	16.049	8.778
31000	50	16.015	8.725
33000	56	17.528	8.880
35000	48	16.609	7.695
37000	34	14.432	9.095
39000	25	15.812	8.302
41000	15	17.677	7.322
43000	0	0.000	0.000
45000	0	0.000	0.000
Total	417		

Table 27: Statistics on Aircraft Encounters by Altitude for Hour 4

Upper Altitude (ft)	Aircraft Count	Avg. Horz. Sep.(nm)	Standard Dev.(nm)
1000	0	0.000	0.000
2000	0	0.000	0.000
3000	1	26.011	0.000
4000	0	0.000	0.000
5000	6	20.024	6.584
6000	8	15.241	5.329
7000	6	19.759	8.516
8000	1	12.358	0.000
9000	7	15.770	9.909
10000	7	18.675	7.284
11000	2	26.051	0.266
12000	8	16.642	9.253
13000	3	14.861	10.648
14000	2	10.186	12.128
15000	3	16.349	10.914
16000	18	17.199	7.646
17000	8	18.969	7.707
18000	13	18.260	7.413
19000	10	20.120	5.281
20000	14	16.782	6.383
21000	15	18.013	6.135
22000	4	19.353	4.767
23000	2	19.043	8.274
24000	8	17.368	7.677
25000	5	19.674	8.360
26000	11	16.228	7.814
27000	21	16.457	9.471
28000	22	14.081	7.642
29000	30	15.790	5.519
31000	42	17.102	8.294
33000	73	16.473	8.027
35000	52	17.866	7.628
37000	41	16.258	8.370
39000	7	15.771	8.395
41000	4	10.684	11.130
43000	2	17.416	14.389
45000	0	0.000	0.000
Total	456		

Table 28: Statistics on Aircraft Encounters by Altitude for Hour 5

Upper Altitude (ft)	Aircraft Count	Avg. Horz. Sep.(nm)	Standard Dev.(nm)
1000	0	0.000	0.000
2000	0	0.000	0.000
3000	0	0.000	0.000
4000	1	17.970	0.000
5000	1	19.368	0.000
6000	0	0.000	0.000
7000	1	8.233	0.000
8000	0	0.000	0.000
9000	0	0.000	0.000
10000	1	25.658	0.000
11000	1	25.406	0.000
12000	0	0.000	0.000
13000	3	18.163	8.972
14000	0	0.000	0.000
15000	3	18.325	10.418
16000	5	19.797	4.630
17000	5	15.093	3.501
18000	3	17.429	5.664
19000	3	18.578	8.915
20000	0	0.000	0.000
21000	3	20.100	11.633
22000	1	19.620	0.000
23000	2	17.073	8.575
24000	0	0.000	0.000
25000	3	12.220	4.497
26000	6	16.000	9.340
27000	5	14.012	10.864
28000	12	20.642	5.209
29000	4	14.676	8.322
31000	8	17.914	5.624
33000	23	17.571	6.869
35000	9	12.097	7.803
37000	6	11.711	10.201
39000	0	0.000	0.000
41000	4	7.334	8.708
43000	0	0.000	0.000
45000	0	0.000	0.000
Total	113		

Appendix B: Supplement to Section 6.4 - Aircraft Ground Speed

Table 29: Statistics on Ground Speed by Altitude for All Hours

Upper Altitude (ft)	Distinct Aircraft	Average Speed (kts)	Standard Dev.(kts)
1000	16	155.828	28.970
2000	125	195.685	69.472
3000	290	189.672	55.192
4000	418	185.488	53.591
5000	485	187.004	54.073
6000	533	181.101	47.164
7000	565	191.895	50.070
8000	652	194.555	55.626
9000	659	201.473	55.041
10000	648	225.363	71.500
11000	624	231.647	68.894
12000	606	238.438	73.826
13000	583	258.895	74.881
14000	572	269.169	77.270
15000	565	271.335	71.660
16000	554	263.557	71.621
17000	552	271.083	66.049
18000	536	273.030	73.604
19000	512	300.992	76.379
20000	496	288.678	78.684
21000	474	322.564	73.054
22000	461	357.847	82.104
23000	458	362.207	83.296
24000	476	390.630	74.033
25000	470	401.751	80.696
26000	477	404.128	75.373
27000	504	419.064	88.331
28000	513	428.875	46.328
29000	514	474.208	48.980
31000	496	420.656	42.157
33000	446	475.295	39.136
35000	309	406.403	43.378
37000	241	476.865	52.615
39000	154	406.586	56.091
41000	103	469.340	42.291
43000	38	425.339	45.328
45000	11	476.657	39.321

Table 30: Statistics on Ground Speed by Altitude for Hour 1

Upper Altitude (ft)	Distinct Aircraft	Average Speed (kts)	Standard Dev.(kts)
1000	1	155.800	0.447
2000	18	163.150	50.787
3000	58	180.089	55.532
4000	85	179.928	47.911
5000	97	182.343	63.504
6000	105	183.748	52.729
7000	106	189.164	51.210
8000	123	193.867	58.097
9000	125	224.363	60.183
10000	128	222.015	75.179
11000	124	225.588	76.959
12000	121	280.371	78.315
13000	112	292.820	76.691
14000	112	292.099	73.628
15000	109	294.208	78.472
16000	104	277.409	73.535
17000	108	285.298	67.384
18000	101	318.687	82.656
19000	98	336.310	71.363
20000	96	305.197	87.104
21000	92	347.447	60.915
22000	91	357.302	79.426
23000	95	365.420	94.194
24000	95	396.759	72.349
25000	96	395.117	98.800
26000	98	381.675	91.032
27000	101	401.379	86.546
28000	110	443.447	42.413
29000	109	465.761	57.608
31000	108	420.156	40.498
33000	89	469.891	38.945
35000	47	415.217	43.675
37000	39	463.617	61.548
39000	26	392.745	77.007
41000	16	471.665	38.263
43000	5	463.003	35.330
45000	1	413.667	3.082

Table 31: Statistics on Ground Speed by Altitude for Hour 2

Upper Altitude (ft)	Distinct Aircraft	Average Speed (kts)	Standard Dev.(kts)
1000	2	134.000	4.528
2000	26	178.341	56.198
3000	71	194.612	58.501
4000	104	191.197	50.524
5000	117	199.011	52.517
6000	135	182.498	46.350
7000	144	200.719	52.943
8000	160	192.102	55.095
9000	155	194.101	52.506
10000	149	219.756	74.389
11000	145	230.851	69.398
12000	146	247.248	66.313
13000	138	261.796	66.963
14000	138	264.400	76.874
15000	138	264.571	75.101
16000	140	261.598	71.557
17000	133	269.389	73.559
18000	127	270.393	77.314
19000	121	303.508	85.689
20000	114	299.836	87.180
21000	105	332.784	87.534
22000	97	367.327	74.629
23000	99	346.835	76.090
24000	102	407.069	58.015
25000	109	389.877	71.553
26000	105	387.961	85.577
27000	117	416.351	76.718
28000	117	416.594	60.866
29000	121	474.296	46.424
31000	135	417.283	45.880
33000	124	475.845	40.109
35000	88	405.713	42.096
37000	65	471.365	66.715
39000	38	389.515	54.943
41000	35	469.053	37.146
43000	9	451.957	43.742
45000	3	428.188	28.134
Total	2	134.000	4.528

Table 32: Statistics on Ground Speed by Altitude for Hour 3

Upper Altitude (ft)	Distinct Aircraft	Average Speed (kts)	Standard Dev.(kts)
1000	7	157.692	15.542
2000	32	170.311	33.819
3000	89	200.974	44.280
4000	126	196.773	49.995
5000	145	192.207	47.361
6000	156	183.647	43.290
7000	159	189.971	47.649
8000	171	204.677	58.861
9000	169	208.436	53.749
10000	166	231.906	70.029
11000	156	235.734	66.073
12000	151	233.418	76.594
13000	144	247.060	70.643
14000	139	261.956	83.715
15000	135	262.121	71.868
16000	134	273.060	79.492
17000	133	269.438	85.757
18000	133	268.671	66.690
19000	128	290.928	75.955
20000	131	266.889	72.793
21000	128	314.564	76.020
22000	120	350.446	85.501
23000	120	367.828	73.873
24000	128	383.318	78.725
25000	122	385.532	77.293
26000	126	410.792	56.054
27000	137	437.549	75.453
28000	148	425.298	35.269
29000	152	471.260	48.417
31000	154	424.614	38.202
33000	132	464.256	42.164
35000	104	404.434	44.522
37000	91	477.006	46.388
39000	61	401.563	41.612
41000	38	476.915	34.296
43000	17	419.390	49.457
45000	4	469.866	36.933

Table 33: Statistics on Ground Speed by Altitude for Hour 4

Upper Altitude (ft)	Distinct Aircraft	Average Speed (kts)	Standard Dev.(kts)
1000	4	163.250	43.707
2000	40	205.377	61.523
3000	68	183.816	57.094
4000	106	179.335	60.111
5000	131	176.337	51.700
6000	155	175.062	47.375
7000	167	184.008	50.515
8000	198	187.907	50.637
9000	202	193.691	54.347
10000	196	234.109	69.755
11000	182	229.766	60.798
12000	177	227.195	73.291
13000	167	248.044	80.491
14000	161	273.272	72.475
15000	156	280.798	66.093
16000	151	256.397	67.733
17000	153	266.372	61.833
18000	144	274.462	71.386
19000	138	299.946	70.940
20000	130	293.939	70.747
21000	130	318.157	63.323
22000	125	373.401	72.616
23000	122	394.069	78.153
24000	134	391.026	69.902
25000	129	431.141	67.619
26000	136	413.410	73.217
27000	147	412.173	103.305
28000	144	427.749	49.189
29000	145	486.750	41.741
31000	150	421.287	44.242
33000	150	481.041	37.088
35000	106	408.845	43.980
37000	90	486.187	47.333
39000	47	436.066	52.772
41000	36	462.437	49.136
43000	14	415.541	38.414
45000	5	503.179	12.390

Table 34: Statistics on Ground Speed by Altitude for Hour 5

Upper Altitude (ft)	Distinct Aircraft	Average Speed (kts)	Standard Dev.(kts)
1000	2	155.385	4.234
2000	13	245.236	106.123
3000	26	185.790	66.552
4000	35	174.623	55.433
5000	40	188.160	63.405
6000	41	178.307	46.858
7000	51	200.050	37.196
8000	62	189.701	52.919
9000	68	204.101	51.824
10000	72	211.297	60.864
11000	66	240.131	77.280
12000	60	227.913	66.173
13000	57	276.849	75.688
14000	61	259.211	72.201
15000	63	262.496	63.941
16000	60	255.634	63.521
17000	64	269.583	43.612
18000	60	253.306	64.781
19000	58	276.196	68.515
20000	52	304.375	73.832
21000	48	311.544	69.588
22000	47	329.801	96.840
23000	46	327.347	74.638
24000	49	383.839	83.847
25000	46	415.350	78.733
26000	47	403.139	83.581
27000	51	422.676	83.435
28000	42	438.148	41.222
29000	46	462.130	39.922
31000	50	413.329	42.597
33000	57	489.247	26.340
35000	41	392.991	35.298
37000	39	472.303	32.356
39000	24	424.503	44.187
41000	27	462.266	53.434
43000	10	418.269	41.419
45000	1	398.355	3.747

Appendix C: Supplement to Section 6.8 - Air Traffic Maneuvers

Table 35: Count of Maneuvers by Altitude, Vertical and Horizontal Phase of Flight

Upper Altitude (ft)	Vertical Phase	Horizontal Phase of Flight	
		STR	TURN
1000	ASC	6	9
	DES	0	3
	LEV	3	5
2000	ASC	43	51
	DES	31	34
	LEV	57	70
3000	ASC	109	119
	DES	91	92
	LEV	156	150
4000	ASC	103	85
	DES	136	109
	LEV	236	150
5000	ASC	127	68
	DES	161	98
	LEV	293	126
6000	ASC	123	89
	DES	190	114
	LEV	338	110
7000	ASC	133	71
	DES	207	102
	LEV	336	98
8000	ASC	118	66
	DES	316	161
	LEV	339	96
9000	ASC	76	39
	DES	312	173
	LEV	332	64
10000	ASC	138	62
	DES	320	149
	LEV	335	70
11000	ASC	91	40
	DES	338	85
	LEV	314	68
12000	ASC	85	32
	DES	336	43
	LEV	309	45
13000	ASC	35	11
	DES	326	37
	LEV	306	35

14000	ASC	27	20
	DES	323	42
	LEV	301	32
15000	ASC	41	23
	DES	319	42
	LEV	304	31
16000	ASC	60	34
	DES	304	38
	LEV	285	26
17000	ASC	63	37
	DES	298	43
	LEV	284	29
18000	ASC	49	23
	DES	291	22
	LEV	284	26
19000	ASC	50	29
	DES	284	19
	LEV	271	31
20000	ASC	46	23
	DES	268	22
	LEV	251	41
21000	ASC	41	26
	DES	249	15
	LEV	245	30
22000	ASC	46	24
	DES	250	24
	LEV	232	32
23000	ASC	46	29
	DES	255	28
	LEV	230	43
24000	ASC	90	47
	DES	253	30
	LEV	238	36
25000	ASC	61	31
	DES	244	27
	LEV	252	39
26000	ASC	68	32
	DES	251	21
	LEV	268	44
27000	ASC	101	55
	DES	255	31
	LEV	285	49
28000	ASC	159	77
	DES	254	34

	LEV	302	59
29000	ASC	185	104
	DES	251	34
	LEV	307	53
31000	ASC	230	130
	DES	242	35
	LEV	300	53
33000	ASC	267	172
	DES	214	44
	LEV	239	36
35000	ASC	192	110
	DES	142	22
	LEV	145	24
37000	ASC	171	118
	DES	116	25
	LEV	109	16
39000	ASC	104	54
	DES	79	11
	LEV	57	11
41000	ASC	89	61
	DES	59	12
	LEV	34	10
43000	ASC	35	21
	DES	16	4
	LEV	13	4
45000	ASC	10	6
	DES	6	0
	LEV	4	2

Appendix D: Supplement to Section 7.2 - Aircraft Models

Table 36: Count and Percentage of Aircraft by Model Type

Model Type	Aircraft Count	Percent of Total
MD80	145	0.093
B733	72	0.046
DC9Q	65	0.042
SF34	63	0.040
B722	51	0.033
B752	48	0.031
DC9	39	0.025
BE20	38	0.024
BE58	38	0.024
B735	36	0.023
B72Q	33	0.021
CARJ	32	0.020
F100	32	0.020
BE9L	28	0.018
BE40	27	0.017
B737	24	0.015
C130	24	0.015
A320	23	0.015
LJ35	21	0.013
B732	20	0.013
B73Q	19	0.012
E145	18	0.011
FA20	18	0.011
C560	17	0.011
H25B	17	0.011
C210	16	0.010
C650	16	0.010
B763	15	0.010
PA31	15	0.010
E120	14	0.009
BE30	13	0.008
T38	13	0.008
BE55	12	0.008
C421	12	0.008
C550	12	0.008
B190	11	0.007
C310	11	0.007
JS32	11	0.007
BE36	10	0.006

CL60	8	0.005
FA10	8	0.005
L101	8	0.005
LJ24	8	0.005
LJ31	8	0.005
LJ60	8	0.005
C340	7	0.004
JS41	7	0.004
PA32	7	0.004
WW24	7	0.004
A306	6	0.004
AT45	6	0.004
B734	6	0.004
B772	6	0.004
C441	6	0.004
C525	6	0.004
GLF2	6	0.004
LJ25	6	0.004
LJ55	6	0.004
SBR1	6	0.004
A319	5	0.003
ASTR	5	0.003
B350	5	0.003
B762	5	0.003
C414	5	0.003
M20	5	0.003
PA34	5	0.003
PAY2	5	0.003
PC12	5	0.003
AC90	4	0.003
BE10	4	0.003
C182	4	0.003
H25A	4	0.003
JS31	4	0.003
SH33	4	0.003
AEST	3	0.002
AT72	3	0.002
C141	3	0.002
C177	3	0.002
C402	3	0.002
C501	3	0.002
C750	3	0.002
DC8Q	3	0.002
FA50	3	0.002
GLF3	3	0.002

H60	3	0.002
LJ45	3	0.002
LR35	3	0.002
MD90	3	0.002
P31T	3	0.002
PAY1	3	0.002
PAY3	3	0.002
SW3	3	0.002
SW4	3	0.002
A124	2	0.001
A340	2	0.001
AC69	2	0.001
AT38	2	0.001
B52	2	0.001
B721	2	0.001
B727	2	0.001
B738	2	0.001
B744	2	0.001
BE60	2	0.001
BE99	2	0.001
C12	2	0.001
C172	2	0.001
C208	2	0.001
C401	2	0.001
CL64	2	0.001
DC86	2	0.001
DC87	2	0.001
E6	2	0.001
F16	2	0.001
F2TH	2	0.001
GC1	2	0.001
H25C	2	0.001
KR35	2	0.001
MD11	2	0.001
MXT7	2	0.001
P32R	2	0.001
PA24	2	0.001
PA27	2	0.001
PA28	2	0.001
PA46	2	0.001
T37	2	0.001
2T38	1	0.001
A10	1	0.001
A310	1	0.001
AA5	1	0.001

AC11	1	0.001
AC50	1	0.001
AC70	1	0.001
AC95	1	0.001
AC9T	1	0.001
AT43	1	0.001
B2	1	0.001
B55	1	0.001
B73B	1	0.001
B742	1	0.001
BE18	1	0.001
BE33	1	0.001
BE76	1	0.001
BE90	1	0.001
BE95	1	0.001
C135	1	0.001
C160	1	0.001
C180	1	0.001
C185	1	0.001
C335	1	0.001
C337	1	0.001
C82R	1	0.001
CL65	1	0.001
CV58	1	0.001
CVLT	1	0.001
DA50	1	0.001
DC8	1	0.001
E3TF	1	0.001
F15	1	0.001
F900	1	0.001
FA90	1	0.001
G2	1	0.001
GLF5	1	0.001
K35R	1	0.001
L29B	1	0.001
L329	1	0.001
LJ23	1	0.001
LR24	1	0.001
M20P	1	0.001
M20T	1	0.001
MO20	1	0.001
MU2B	1	0.001
P210	1	0.001
P28R	1	0.001
P3	1	0.001

PA23	1	0.001
PA30	1	0.001
PA44	1	0.001
SH36	1	0.001
SW2	1	0.001
T2	1	0.001
TRIN	1	0.001
n/a	1	0.001
Total	1566	1.000